CERTIFIED TRANSLATION OF THE ORIGINAL APPLICATION

CERTIFICATION

I, ANTJE KOPP, professional technical translator and interpreter, having successfully passed the State Examination for Translators and Interpreters of the Federal Land of Bavaria, and duly appointed by, sworn to and commissioned by the President of the Landgericht *[Regional Court]* Muenchen I,

residing at Taimerhofstrasse 10, D-81927 Muenchen and having my office at Richard-Strauss-Str. 56/IV, D-81677 Muenchen, Germany,

do hereby declare, under penalty of perjury under the applicable laws, that I am fully conversant with the German and English languages, and that the attached English rendition of the complete text of the international Patent Application No. PCT/DE00/03284 of September 21, 2000, entitled:

"Shelf Storage Facility"

is, to the best of my ability and knowledge, a true and correct translation, accurate in every particular.

Muenchen, this 20th day of March 2002.

Antje Kopp
Richard-Strauss-Strasse 56/IV
D-81677 Muenchen
Federal Republic of Germany

Shelf Storage Facility

In dispensing chemist's shops, for example, shelf storage facilities are required that are capable of storing an extremely great number of different products for easy retrieval in a comparatively narrow space. A very substantial part of these products to be stored is available only in a single package at all, and moreover, the dimensions are different from one product to the next. There are practically hardly any different products presenting the same dimensions of the package in which they are accommodated.

For storage of these products the use of so-called drawer cabinets is known. These drawer cabinets consist of a case or a body in which a drawer insert, which includes shelves, is suspended for displacement in the longitudinal direction. Such drawer cabinets can be used only in those drugstores where the chemist's office offers sufficient space for installation of the drawer cabinets. As soon as the area becomes smaller the products must be stored at other places. This creates the problem of transporting the products from the storage room onto the chemist's office. Moreover, the product must be taken out of the shelf storage facility and placed into the conveying vehicle or new products must be distributed in the shelf storage facility.

The conventional drawer cabinets are less suitable to this end because as a result of the strongly different sizes of packages the cabinets present an unnecessary volume. The major part inside the cabinets is unused space. Moreover, the cabinets cannot be used for automated withdrawal of desired products for placing them onto a conveyor means.

In practical operation, an automated shelf storage facility is known, particularly for application in dispensing chemists' offices, where very long plane shelves are used instead of the drawer cabinets, on which the products are placed. The storage in such a storage facility is chaotic, with application of a storage management system. In the management system the site of the desired product is stored. The coordinates of the site are the number of the shelf and the distance, measured in meters, from a reference point, mostly at the beginning of the shelf. This data is communicated to a storage and retrieval device that moves along the shelf in correspondence with the metric information and then withdraws the product by means of a vacuum gripper for drawing it onto the storage and retrieval device.

The practical operation with such a system has proven a number of weak points. Occasionally, the packages are not perfectly sealed. Attempting to draw the package onto the storage and retrieval device, the vacuum gripper opens the flap. Hence, a proper movement of the product is no longer ensured.

When the bending fold of the flap is at the top the package assumes an oblique position in the gap between the storage and retrieval device and the shelf, with the contents of the package being discharged onto the floor.

When the bending fold of the flap is located at the side the package is occasionally drawn in an oblique position such that it hits against adjacent products. As these adjacent products, too, rest on the plane shelf only loosely they are pushed out of their position. In the subsequent attempt to grasp the obliquely positioned neighbouring package, the grip elements are not in the position to attract the package correctly by suction. Moreover, their oblique angle must not exceed a maximum of 5° to 10° or else the grip elements are not capable of seizing the package.

When a failure occurs in the known system the storage and retrieval device must be carried into an extreme position and the staff must go into the corridor where the storage and retrieval device normally moves, in order to take the packages personally from the shelf storage facility in correspondence with the aforementioned coordinates. This involves the further risk of accidentally hitting against the stored products and pushing them out of their position. Each product moved out of the rated position must be laced against into the shelf storage facility anew after the automated operation has been resumed.

The strongly varying sizes of the packages and the strongly different weights varying from a few grams to almost half a kilogram result in further difficulties in the vacuum grippers for the products.

Moreover, in the known system the three-dimensional depth of the shelf, which is dimensioned for depositing the largest package admissible, cannot be utilised for storing several small packages one behind the other because it is practically impossible to have access to a product lying in the second row. By the way, the known system is not equipped with provisions to this end.

Starting out therefrom, the present invention is based on the problem of providing a shelf storage facility that permits the placement of a plurality of products in a space-saving manner, with the possibility to handle even strongly different product sizes in a perfect manner.

In accordance with the present invention, this problem is solved with the shelf storage facility presenting the features defined in Claim 1.

In the new shelf storage facility, the individual products do no longer rest directly on shelves but rather shelf bays are provided for the products in which the products are stored on suitable supports. The product supports are provided with guiding means that permit a correct positioning of the product supports in the correct position in the respective shelf bay.

The storage and retrieval device is hence enabled to remove from the shelf bay the product support with the product or the products, so that vacuum grippers that grip into the shelf and possibly cause problems there may be dispensed with.

Even if in the new shelf storage facility that is suitable for automation a troubled situation should occur and require manual removal there is no risk of the stored products or product supports being displaced from their position by a movement past them. The products are rather correctly retained by the mutually cooperating guiding means on the shelf bay and the product support.

Another advantage of the use of product supports consists in the utilisation of the three-dimensional depth of the respective shelf bay as it is easily possible to deposit several products of the same or a different size one behind the other on the product support and to separate them then with the assistance of the storage and retrieval device. The removal of individual products from the product support permits the return of the remaining products on the same product support again back into the same shelf bay, so that it is easily possible to utilise largely the spatial depth. In this manner, a much more compact storage is possible, compared against prior art.

The structure becomes simple when the shelf bays are disposed in groups and the shelves of one group are connected to each other. A further simplification can be achieved when the shelves verge into each other in an integral manner.

The utilisation of the spac in the shelf storage facility becomes good when the shelf bays present different sizes only in respective groups. Experience has shown that in the new shelf

storage facility preferably two, at most three different sizes of shelf bays are required in order to be able to store all product sizes occurring at a minimum of unused space.

The design of the shelf bays becomes particularly simple when the bays do not present any limiting walls at the sides, which means that each shelf bay verges laterally into the next adjacent shelf bay in an open manner.

A very simple guiding means for the product support is achieved when the guiding means is formed by the geometry of the respective shelf. For example, the shelf per shelf bay may comprise a guiding channel extending in the longitudinal direction of the shelf bay and open in the upward direction. The lower side of the product support is adapted in a suitable manner so that a movement of the product support is still possible only in a direction parallel to the longitudinal extension of the channel. On account of the obliquely extending walls, the channel ensures the automatic centring in the transverse direction. Positioning errors cannot accumulate in the course of time. Even product supports not precisely introduced will be forced by the guiding means to assume their ideal position.

A very simple channel is obtained when the shelf presents two plane surfaces extending in a V-shaped configuration or when the shelf is formed by these surfaces only. The V-shaped arrangement of the surfaces prevents the product support from tilting on the shelf whilst it ensures automatically a proper centring, without any adaptations being required.

Even in the case of shelves with a V-shaped channel, which do not present any horizontally extending surface sections in any other respect, the shelves may verge into each other in an integral manner such that an undulated plate is created with troughs and apexes. The apexes are the imagined boundaries serving as separation from adjacent shelf bays.

When the shelf bays or shelves, respectively, are combined to form groups and when one respective group is fastened on a supporting beam it is very easily possible to vary the spacing of the shelves from each other and to adapt them to the required conditions.

The elimination of trouble and the storage and removal by hand is simplified when several groups of shelf bays are accommodated in a drawer rack that is disposed for longitudinal displacement in a shelf rack, in a way similar to a drawer cabinet. In the case of trouble the respective troubled drawer shelf can be withdrawn and is comfortably accessible from all sides, as is known from drawer cabinets.

The corridor between mutually opposing shelf racks must only have a width that is required for the movement of the storage and retrieval device. With this solution, the dimensions of the human body need not be taken into consideration.

In order to avoid also a sliding movement of the products on the product supports the latter are provided with appropriate guiding means on their upper side. These guiding means may have the same shape as the guiding means in the shelves, which means that they may be formed by a preferably V-shaped channel.

When both the guiding means in the shelf and the guiding means on the upper side of the product support have the configuration of a V-shaped channel the product support is simplified and assumes the shape of an angular bar that rests in the respective shelf bay and on which the products are supported. It is a matter of fact that the orientation of the channel is so designed that its side walls enclose each an angle of 45° relative to the horizontal.

All product supports of the shelf storage facility are of equal length. The length is preferably so dimensioned that two – expediently three – products of medium size can be accommodated on the product support one behind the other. The dimension of the product of medium size is calculated by approximation from the mean value of the dimensions of all products. For simplification the approach may be taken that products of the same dimensions are considered merely once in the calculation of the mean value, which means that their frequency of occurrence is left out of consideration.

Moreover, improvements of the invention are the subject matters of dependent Claims.

The drawing illustrates an embodiment of the subject matter of the invention. In the drawing:

Fig. 1 illustrates the inventive shelf storage facility in a schematic perspective view, with one drawer rack being partly withdrawn;

Fig. 2 is a view of one of the product supports of the shelf storage facility according to Fig. 1;

Fig. 3 shows a perspective enlarged view of the shelf storage facility according to Fig. 1;

Fig. 4 is an illustration of the storage and retrieval device according to Fig. 3, seen from the shelf bays;

Fig. 5 is an enlarged perspective view of the actuating finger of the storage and retrieval device according to Fig. 3, and

Figs. 6 to 11 illustrate the operation of storing and removal by strongly schematic clipping views in which all parts that are not essential for the understanding of the operation of removal have been omitted.

Fig. 1 is a perspective and schematic view of a shelf storage facility 1. Two opposing shelf racks 2a and 2b are part of the shelf storage facility 1, which are spaced from each other in mutual opposition by their wide sides, with two vertical supports 3a and 3b rising in the space between the two shelf racks 2a and 2b, on which a respective storage and retrieval device 4 (Fig. 3) is vertically guided.

Each of the two shelf racks 2 has a squared outside shape, with merely the edges of the right parallelepiped existing.

The shelf rack 2b is composed of four vertically rising supports 5, 6, 7 and 8 that are interconnected at their ends by four respective cross struts 9, 11, 12 and 13 at the top and corresponding cross struts at the bottom of which merely the cross struts 14, 15 and 16 can be seen. The supports 5 ... 8 and the cross struts 9 ... 16 are fastened to each other at the corners by screwing or welding.

The shelf rack 2a is structured in the same manner with the same dimensions so that a repeated explanation may be dispensed with; the reference numerals of the shelf rack 2b apply in the same manner for the laterally reversed structural elements of the shelf rack 17b.

In each of the two shelf racks 2a and 2b two drawer racks 17a and 17b are accommodated for longitudinal displacement. They are suspended, for example, in the shelf rack 2 on the upper end thereof by means of ball guides that are not illustrated but known per se, to which end these guides are expediently mounted in the region of the upper cross struts 9 and 12. In this manner, the drawer racks 17 can be withdrawn towards the narrow side of the two shelf racks 2, which faces the person looking at them, as can be seen by the example of the drawer rack 17a in Fig. 1. Withdrawal in the opposite direction is blocked so that the two drawer racks 17, in their retracted condition, will present a defined extreme position in the respective shelf rack 2.

The distance between the supports 5 and 7 is wide enough so that withdrawal of the narrower drawer rack 17 will be possible.

In a manner similar to the shelf rack 2, the drawer rack 17a is a squared formation of which merely the edges exist in the form of vertically extending struts 18, 19, 21, 22 and of cross struts 23 ... 29 disposed at the respective ends. On account of the illustration, the rear lower cross strut of the drawer rack 17a is hidden.

The drawer rack 17b is configured in a manner identical with the configuration of the drawer rack 17a so that a repeated description may be dispensed with and the reference numerals of the drawer rack 17a apply in the same manner for the laterally reversed structural elements of the drawer rack 17b.

As may be also seen in Fig. 1, both the shelf rack 2 and the drawer rack 17 form each comparatively large flat sides that are oriented in parallel with each other in any operating position. In the shelf rack 2, for example, this flat side is surrounded by the supports 7 and 8 of the upper cross strut 12 as well as of the lower cross strut extending in parallel to it, which is not visible. In the drawer rack 17, these are the vertical struts 19, 21 and the cross struts 26 and 28. These flat sides of both the shelf rack 2 and the drawer rack 17 are referred to as front sides whilst the areas parallel to them are to be considered as rear sides. The shelf racks 2 face each other by their front sides so that the front sides of the drawer racks 17, too, are disposed in opposition to and spaced from each other.

Between the vertical struts 18 and 22 of each drawer rack 17, several crossbeams 31 extend horizontally and hence in parallel with the cross struts 24 and 26, which crossbeams are connected to the vertical struts 18 and 22 for adjustment. They are adjustable in the sense that they can be fastened at any level whatsoever at the two vertical struts 18 and 19, while they are permanently disposed with a horizontal orientation.

Each of the crossbeams 31 carries an associated shelf plate 32 that can best be seen in the clipping view of Fig. 3. The shelf plate 32 is a rectangular moulded and punched sheet metal part having a rear edge 33 and a parallel front edge 34. The shelf plate 32 is welded by the rear edge 33 to the respective crossbeam 31. Starting out from the latter, it projects freely in a direction towards the front side of the respective drawer rack 17.

Each of the shelf plates 32 presents the same three-dimensional depth, measured in a direction orthogonal on the front side of the respective drawer shelf 17, whilst it is so designed that it forms a plurality of channels 35 extending in parallel one beside the other, which have a V-shaped configuration and constitute an opening angle of 90°. The V-shaped channels 35 extend from the rear edge 33 to the front edge 34. They are all parallel to each other, without

exception, and present precisely the same dimensions on a respective shelf plate 32. However, they may vary in terms of th dimensions from th shelf plate 32 to the n xt shelf plate 32, as can be seen in Fig. 1 in the region of the upper shelf plates visible there.

Each of the V-shaped channels 35 is defined by two plane surfaces 36 and 37 that verge into each other in an integral manner in the region of a lower apex 38 and into the walls 36 and 37 of the respective laterally adjacent channel 35 in the region of upper apexes 39. The apexes 38 and 39 are straight and are orthogonal on the respective crossbeam 31.

As will become evident in even more details from the description of the function presented in the following, each channel 35 constitutes a shelf bay while the walls 36 and 37 constitute a shelf plate 41 of the respective shelf bay.

The individual shelf bays 35 verge into each other in a horizontal direction, without lateral partitioning walls. In the vertical direction, they are separated from each other by the respective next shelf plate 32.

One product support 42 rests in each shelf bay 35, which is shown in an enlarged, perspective and shortened form in Fig. 2. The product support 42 is a moulded plastic part consisting of two plane straight walls 43, 44 extending over the length of the product support 42 and having a constant thickness. The two walls 43 and 44 enclose an angle of 90° between them and are connected to each other in an integral manner along one edge 45. The length of the product support 42 is dimensioned to be slightly longer than the length corresponding to the depth of the shelf plate 32, measured between the rear edge 33 and the front edge 34.

The wall 44 has a greater thickness than the wall 43 and permits the formation of two recesses 46 located in the vicinity of the immediately adjacent front edge of the product support 42. The position of the recess 46 and the length of the product support 42 is so dimensioned that when the product support hits against the crossbeam 31 it projects by one recess 46 beyond the freely salient front edge 34 of the shelf plate 32, which means that it protrudes from the respective shelf bay 35.

The height of the walls 43 and 44 of the product supports 42 is so dimensioned that when they rest in the structurally associated shelf bay 35 they stand back slightly from the two laterally adjacent upper apexes 39.

As will be easily evident and understandable, the product supports 42 are inevitably guided in their longitudinal direction in the shelf bays 35 and cannot tilt to the side either. The guiding function is achieved on account of the geometry of the shelf plate 41 and the geometry of the product support 42. The walls 36 and 37, which extend at an angle of 90° relative to each other and which constitute the shelf element 41, constitute, at the same time, the guiding means for the product support 42 whose underside, which is formed by the downwardly showing surfaces of the walls 43 and 44, is matched with this geometry.

The undersides of the walls 43 and 44 hence constitute the guiding means complementary to the guiding means of the shelf bays 35. As moreover the walls 43 and 44 are plates with parallel faces having each the same thickness at any point, with the exception of the recess 46, the product support 42 constitutes an equally V-shaped channel 47 on its upper side for accommodation of the products 48 to be stored, such as medicament packages, in operation. Fig. 3 illustrates one of the product supports 42, which carries two products 48a and 48b.

As the medicament packages mostly have a squared shape they may be stored in a position in which they rest obliquely in the product supports 42, as is illustrated in the drawing, while they rest on one side on the upper side of one of the two walls 43 and 44. When the products 48 are stored it is noted that all the products 48 rest in all product supports 42 in the same tilted manner. With this provision those products 48 that project upwardly beyond the adjacent upper apex 39 will be prevented from colliding with other products 48 in an adjacent shelf bay 35, which equally project beyond the upper apex 39.

On account of the V-shaped upper side of the product support 42, the products 48 once stored in this manner cannot vary their position in the product support 42. Moreover, they are oriented, in terms of their longitudinal extension, in parallel with the shelf bay 35 because they are retained so fixedly by the V-shaped channel 47 of the product support 42 that the edge resting in the channel 47 will be fixed in the channel 47.

A special representation is not necessary in order to become aware of the fact that even unpacked cylindrical objects such as small bottles and ampoules can be accommodated in the V-shaped channels 47 of the product supports 42, without the risk of variation of their orientation or the risk of rolling of the product support 42.

In operation of the illustrated shelf storage facility 1 attention is paid to the fact that the products 48 will project upwardly beyond that edge of the respective wall 43 or 44, which is away

from the edge 45, by 1/3 at maximum when they rest in the product support 42, as is illustrated in Fig. 3.

For manipulation of the product support 42 and the products 48, the storage and retrieval device 4 is provided. The storage and retrieval device 4 moves horizontally on a cross arm 49 that is guided for displacement in a vertical direction between the two supports 3a and 3b. The cross arm can be vertically adjusted, for example by means of toothed belts 5 whilst the storage and retrieval device 4 can be horizontally displaced on the cross arm 49 by means of driving systems that are not illustrated either. Such driving systems are common and need not be discussed in details because they are not essential for the comprehension of the invention.

Due to this form of support of the storage and retrieval device 4, this device can be adjusted relative to two co-ordinates orthogonal on each other, while it moves in front of the freely salient front edges 34 of the shelf plates 32 of the two drawer racks 17a and 17 in a vertical plane.

According to Figs. 3 and 4, the storage and retrieval device 4 comprises a substantially tubular housing 52 with a bottom 53, two side walls 54 and 55 as well as an upper side 56. The side walls 54 and 55 extend in parallel with each other and at a right angle relative to the bottom 53. Both the bottom 53 and the two side walls 53 and 54 are substantially smooth whilst the upper side 56 is structured. The tubular housing 52 is open towards the two ends, with each end of the storage and retrieval device 4, which is located in the longitudinal direction of the storage and retrieval device 4, being opposite to the front side of an adjacent drawer rack 17a or 17b.

As is best visible in Fig. 4, the upper side of the storage and retrieval device consists of two L-bars 57 and 58 extending in the longitudinal direction. The L-bar 57 is composed of two branches oriented at a right angle relative to each other while the L-bar 58 consists of two branches 62 and 63 extending at a right angle relative to each other. The branches 61 and 63 are fastened on the inner side of the two side walls 54 and 55 at an angle of 45°. Between the branches 59 and 62 a V-shaped channel 64 is created that is defined by two smooth side walls, i.e. the branches 59 and 62. The channel 64 extends along a straight line between the two ends of the storage and retrieval device and is open on each face end.

The branches 59 and 62 do not abut each other by their free edges. At its deepest point, the channel 64 is provided with a continuous gap 65 through which the channel 64 is open in a

downward direction. As is shown in Fig. 4, a product support 42 can be inserted into this channel 64, specifically in a manner that the lower edge 45 with the recesses 46 of the support is accessible through the gap 45.

A guide rail 66 extends in the housing 42, which is fastened on the upper side of the bottom 53. The guide rail 66, which extends over the length of the housing 42, carries an undercut guiding groove 67 on its upper side, in which a carriage 68 is guided via rolling bodies not visible in more details. The carriage 68 carries a bracket 69 on its upper side. The bracket 69 projects beyond the carrier 68 on both sides, with a mounting angle 71 being fastened on the bracket 69, as is shown on the left side in Fig. 4. The mounting angle 71 serves to support a geared motor 72 whose transmission output shaft 73 extends below the gap 65 and is oriented at a right angle relative to the longitudinal extension of the gap.

Moreover, the bracket projects to the right side beyond the carriage 68 for supporting or forming a compensation weight for the geared motor 68. The balancing weight is not illustrated here.

The geared motor 72 is a servo motor whose output shaft 73 can be controlled in defined angular positions. An actuating finger of the type illustrated in an enlarged view in Fig. 5 is disposed on the output shaft 73 for rotation therewith. The actuating finger 74 is provided with a receiving bore 75 on one end for the passage of the output shaft 73. The means for securing the finger for rotation on the output shaft 73 are not illustrated because they are not essential for the comprehension of the invention.

Starting out from the receiving bore 75, the actuating finger 74 forms an arm 76 on whose free end two hooks 77 and 78 are formed. The two hooks 77 and 78 extend towards opposite direction, measured in a plane on which the axis of the bore 75 is orthogonal. A plane face surface 79 extends between the two hooks 77 and 78. The hooks 77 and 78 are used to move the product support 42 or the products 48 stored in the channel 64, as will be explained in more details in the following.

For movement of the bracket 69 along the guide rail 66 into defined positions a further geared motor 81 is provided that is equally designed as servo motor. Its output shaft 82 extends in parallel with the output shaft 73 and hence at a right angle relative to the longitudinal extension of the guide rail 66.

The output shaft 82 carries a pulley 83 for a toothed belt, which serves to drive an endless toothed belt 84 whose operative section can be seen between the toothed-belt pulley 83 and the underside of the bracket 69. The endless toothed belt 84 is passed over two deflection sheaves 85 in the form of loose pulleys supported on the rail 66 for free rotation in the vicinity of the ends of the guide rail 66. Tensioning means for tensioning the toothed belt 84 are equally provided even though they are not illustrated in the drawing or not visible in Fig. 3 because they are hidden by the side wall 45.

The toothed belt 84 is fixed to the underside of the bracket 69 at one point. When the servo motor 81 is started the bracket 69 and along with it also the actuating finger 74 is moved in the longitudinal direction of the gap via the pulley 83 for a toothed belt and by means of the toothed belt 84.

For synchronisation of the two servo motors 72 and 81 reference means are provided in a manner known per se, which are linked up to the central control system in a manner known per se. Hence, the central control system knows both the precise angular position of the actuating finger 74 and the position of the output shaft 73 relative to the longitudinal extension of the gap 65.

A further geared motor 86 is mounted on the outside of the branch 63, which drives a shaft 89 via spur-toothed wheels 87 and 88, which shaft is supported for rotation on the outside of the branch 63 in bearing blocks 91. Two L-shaped levers 92a and 92b are connected to the shaft 89 for rotation therewith, which levers present branches 93a or 93b, respectively, which act as retaining fingers. As can be seen in Fig. 3, the retaining finger 93 can be oriented in an upward direction or it may be pivoted into the channel 67 formed by the product support 42, as is shown in Fig. 4, with a sufficient clearance being retained in this position relative to the two walls 43 and 44.

The retaining fingers 93 are provided directly beside the ends of the channel 64 so that they are able to shut off the channel 64 optionally at its both ends. The distance between the retaining fingers 93 is slightly longer than the length of the product support 42.

As the actuating finger 74 can be moved, too, by means of the guide rail 66 towards both ends of the gap a symmetric mode of operation is possible, in terms of the function, which means that the storage and retrieval device 4 can operate the shelf bays 35 of the drawer rack 17a in the same manner as the shelf bays 35 in the drawer rack 17b, in both cases at any level whatsoever.

With reference to Figs. 6 to 11, the precise mode of operation of th novel shelf storage facility will be explained. In Figs. 6 to 11 merely those elements are schematically indicated which are relevant for the comprehension of the mode of operation.

Figs. 6 to 11 hence show one of the channels or shelf bays 35 in an exemplary view, which is fastened on the crossbeam 31. For instance, the wall 37 of the channel 35 can be seen. A product support 42 is located in the channel 35 or the shelf bay 35, respectively, with the underside or rear side of the wall with the recess 64 being visible in Fig. 6, which projects beyond the front edge 34. In Fig. 6 the cut-open channel 64 of the storage and retrieval device can be seen on the right side of the shelf bay 35, specifically in a view onto the upper side or the outside of the branch 63 whose lower edge constitutes a defining edge of the gap 65. In a laterally reversed illustration, below the branch 63, the output shaft 73 of the geared motor 72 is visible, with the motor being drawn in turned-around position with the actuating finger 74 disposed thereon for rotation therewith. The means for longitudinal displacement of the geared motor 72 and hence of the actuating finger 74 as well as the associated guiding means have been omitted here for reasons of clarity.

Finally, one respective retaining finger 93 is visible above the branch 63 at the ends.

In the illustrated shelf storage facility, the products 48 are stored in a chaotic form. When the products are stored the central control system receives information about the lengths of the edges of the products 48, the product name or the designation of the article, the address or position of the respective shelf bay and the position of the product on the product support 42 and the oblique position.

As initial position for the explanation of the function it should be assumed that the product support 42 rests in its shelf bay 35 and is pushed up to the crossbeam 31. The first recess 46, which is remote from the crossbeam 31, is freely accessible.

A total of three products 48a, 48b and 48 c rests on the product support 42, which products are distinguished from each other in terms of the dimensions of their packages. All the products 48 are positioned in the same tilted oblique manner in the product support 42, which can best seen in Fig. 3.

When, for instance, the product 48c is to be retrieved from the illustrated shelf bay 35 the central control system moves the storage and retrieval device 4 in front of the respective shelf bay 35. To this end, the cross arm 49 with the storage and retrieval device 4 is carried

to the appropriate level and then the storage and retrieval device 4 is oriented along the cross arm 49 to the respective shelf bay 35. Orientation means in this case that the channel 64 of the storage and retrieval device 4 is aligned with the channel defining the shelf bay 35 with respect to the horizontal direction whilst it is slightly lower in the vertical direction. In this position, there is a small gap between the freely accessible face edge of the product support 42 and the opposite end of the channel 64.

The central control system, which has adjusted the actuating finger 74 in the standardised position before in a manner known per se, specifically with respect to its angular rotational position and its position in the longitudinal direction relative to the gap 65, now causes the geared motor 81 to move the geared motor 82 with the actuating finger 74 in a direction towards the product support 42. The movement is stopped as soon as the hook 77, which extends in the upward direction in this drawing, for instance, is located below the recess 46. In order to carry the actuating finger 74 into this position the finger had been pivoted before into a horizontal position in which none of the hooks 77 and 78 is introduced into the gap 56. Hence, the actuating finger 74 can be carried underneath the product support 42 without any obstacle.

As soon as the finger is in its correct position, the control system causes a rotation of the actuating finger 74 from the horizontal position into a first upwardly pivoted position in which the respective hook 77 or 78, respectively, which is directed upwards, engages into the recess 46 without lifting the product support 42. It is obvious that the hooks 77 and 78 cooperate with the recesses 46 as coupling means for coupling now the storage and retrieval device 4 to the respective product support 42. Hence, the position according to Fig. 6 is reached.

Unless the fingers 93 have not yet been pivoted, the retaining fingers 93 are now pivoted upwards out of the channel 64.

The control system now causes the geared motor 81 to start again, this time in the opposite direction so that the actuating finger 74 will draw the product support 42 hooked to it completely onto the channel 74 until the rear edge of the product support 42, which bears against the crossbeam 31 in Fig. 6, is retracted behind the clearance of the left retaining finger 93. This extreme position can be seen in Fig. 7.

Now the central control system causes the retaining finger 93 to pivot into the channel 64 by means of the geared motor 86.

As soon as the retaining fingers 93 have been pivoted down the central control system starts the servo motor again in a direction towards the shelf bay 35 from which the product support has just been withdrawn. However, before the level of the cross arm 49 is slightly varied so as to avoid a collision between the rear edge with the front edge 35 when the product support 42 is pushed back into the shelf bay 35. When now the product support 42 is pushed back into its shelf bay 35 by means of the servo motor 81 the products 48a, 48b and 48c resting on the product support 42 cannot follow the movement because the product 48a hits against the retaining finger 93. Due to the longitudinal movement of the actuating finger 74 in a direction towards the shelf bay 35, the products 48 on the product support 42 are displaced in a direction towards the actuating finger 74. During this movement, the product 48c, which is next to the actuating ringer 74, is the first to drop down into the channel 64 of the storage and retrieval device 4.

As the central control system has recorded for each product which edge dimensions the object presents, in which shelf bay 35 and at which position on the product support 42 the object is stored, already by the time of storage of the products, the central control system knows when the product support 42 has been displaced by a sufficient distance so that with the addition of a certain tolerance distance the product 48c will be certainly pushed down from the product support 42 and will rest in the channel 64.

Now the advance for the actuating finger 74 will be interrupted for a short period for pivoting the retaining finger 93 in an upward direction during this short interval. The clearance profile of the product 48a is now free again and the product support 42 together with the two products 48a and 48b remaining on it can be pushed back into its shelf bay 35. The extreme position of this movement is illustrated in Fig. 9. Now, the associated product support 42 is located again in the shelf bay 35 and still carries only the two products 48a and 48b whilst the product 48c rests on the storage and retrieval device 4.

The central control system now causes the servo motor 72 to pivot the actuating finger 74 downwards in order to carry it out of engagement with the product support 42. Then, by means of the servo motor 81, the actuating finger 74, together with its servo motor 72, is carried into the right extreme position according to Fig. 10 while it passes underneath the product 48c located on the storage and retrieval device 4. When it has reached this position or while the actuating finger 74 moves into this position, the storage and retrieval device 4 is carried by the control system to a distribution chute 94 whose side wall can be seen in Fig. 1.

This distribution chute 94 joins the end of one of the shelf plates 32 and constitutes there an extension of the last side wall 37 directed downwards, which leads to the outside.

When the storage and retrieval device reaches this coordinate point the actuating finger 74 is pivoted upwards behind the product 48c by means of the servo motor 42, specifically to an extent higher than this would be necessary for coupling the product support 42. When the pivoted position for coupling the recess 46 of the product support 42 is not high enough the actuating finger 74 would pass by the product 48c without any effect. As it is intended, however, to move the product 48c from the storage and retrieval device 4 the actuating finger 74 is carried into an upright position to project clearly into the clearance profile of the channel 64 in order to be able to hit against the product 48c. With a further advance to the left side, the product 48c is pushed out of the channel 64, as is illustrated in Fig. 11, and can then be transferred via the distribution chute 94 to a further conveyor system not illustrated in more details here.

The mode of operation of the entire system has been illustrated in Figs. 6 to 11 for the case that a product support 42 from the left drawer rack 17a is handled. In an analogous and similar manner, only in a laterally reversed arrangement, a product support 42 can be moved out of the right drawer rack 17b and managed appropriately. To this end, the actuating finger 74 is carried into a position which is laterally reversed relative to the positions illustrated in Figs. 6 to 11. As each product support 42 is provided with the recesses 46 in the vicinity of both ends the coupling with the product supports 42 in the right drawer rack 17b can be easily managed without the need to displace the actuating finger 74 in a direction parallel to the output shaft 73. It is always positioned in the gap 65 in the same position as that which is clearly visible in Fig. 4.

In the foregoing, it has been explained how the product 48c can be moved to the distribution chute 94. When the product 48a is required instead of the product 48c the retaining finger 93 remains lowered until the product 48a, too, will loosely rest in the channel 64 of the storage and retrieval device, in variation from the illustration in Fig. 8. Then the actuating finger 74 returns into the position according to Fig. 10, the storage and retrieval device 4 moves in front of the distribution chute 94 and as soon as this point is reached the actuating finger 74 is used to push the group of the three products 48a, 48b and 48c one behind the other to the front until the product 48a falls down from the channel 64 of the storage and retrieval device onto the distribution chute 94, in a manner similar to the case illustrated in Fig. 11.

After this has happened, the advance of the actuating finger 74 is stopped. Due to the dimensions of the products 48a, 48b and 48c and their position on the channel 64, as a consequence of the locking action produced by the retaining fingers 93, the control system knows the position of the actuating finger 74 in which the latter has left the product 48a in the channel 64.

The storage and retrieval device 4 now returns to the shelf bay 35 in which the product support 42 rests from which the products 48a, 48b and 48c had been removed before. The storage and retrieval device is carried into a position in which the channel 64 is at a slightly higher level than the channel 47 defined by the product support 42 and then the initially stopped advance movement of the actuating finger 74 is continued. The products 48b and 48c still resting on the storage and retrieval device are pushed back to the free product support 42 until the product 48c is again in the position shown in Fig. 6.

The product 48b in the middle position can be handled in an analogous and similar manner when it is to be stored. In this case, the product support 42 will initially carry still the product 48a only – after it has been returned into the associated shelf bay 35 – and after the distribution of the product 48b the product 48c, which still remains in the channel 64, is returned to the product support 42.

A shelf storage facility 1 comprises shelf bays 35 presenting a V-shaped channel as shelf 41. A product support 42, which has equally the shape of a V-shaped channel, rests in each channel 34. The storage and retrieval device 4, which is used for storing and retrieving the products 48, carries, on its part, a V-shaped channel 64 on the upper side, on which either the product support 42 with the products 48 or a product 48 along, which is to be distributed, can be deposited. By means of an actuating finger 74, which can be pivoted upwards through a gap 65 in the channel 64 of the storage and retrieval device 4, it is possible to displace the product support 42 or the package 48 loosely resting on the storage and retrieval device without a product support 42 to and fro between the shelf bay 35 and the storage and retrieval device 4.